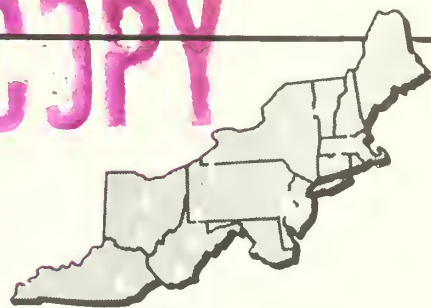


Historic, archived document

Do not assume content reflects current
scientific knowledge, policies, or practices.

1978
EXTRA COPY

Northeastern Forest Experiment Station



FOREST SERVICE, U.S. DEPT. OF AGRICULTURE, 6816 MARKET STREET, UPPER DARBY, PA. 19082

SOME OBSERVATIONS ON AGE RELATIONSHIPS IN SPRUCE-FIR REGENERATION

Abstract. — Measurement of the ages of seedlings of balsam fir (*Abies balsamea* (L) Mill.), red spruce (*Picea rubens* Sarg.), and white spruce (*Picea glauca* (Moench) Voss) 15 years after the first harvest of a two-cut shelterwood operation revealed that very few potential crop-tree seedlings in the sample occurred as advance regeneration in the original stand. Relationships among total height, age, and current growth of the samples are reported, as well as the variation in seedling age encountered.

Knowledge of the development of spruce-fir regeneration under various silvicultural prescriptions can be extremely useful. The age, growth characteristics, and origin of regeneration in both time and space must be known in order to judge the success of a particular silvicultural prescription, and to predict the future performance of individual trees. In this study we determined the age variation in seedlings of crop-tree quality following a shelterwood cutting program and examined the relationships between total age, current leader growth, and total height.

The study area, on the Penobscot Experimental Forest in south-central Maine, was harvested by a two-cut shelterwood system. The original stand averaged 170.6 square feet of basal area with an average diameter of 7.1 inches for trees over 4.5 inches DBH. Fifty-seven percent of the basal area was spruce and fir. The first overstory removal in 1957 took 58.8 square feet or 34 percent of the original basal area. The final harvest in 1967 removed

all but 31 square feet or about 18 percent of the basal area. The result was a very open area with a few scattered individual trees and islands of residual trees. Total stocking of regeneration of all species was 9,640 in 1965 (trees up to 2.1 feet in height or 0.49 inches DBH) and 18,160 seedlings in 1970. In both 1965 and 1970 the percentage of spruce and fir in the regeneration was 48 percent, and spruce alone made up 6 percent. This study was undertaken in the fall of 1971.

Sample trees were chosen at 15-foot intervals along two randomly-located line transects through a portion of the area. We tried to choose balsam fir (*Abies balsamea* (L) Mill.), red spruce (*Picea rubens* Sarg.), and white spruce (*Picea glauca* (Moench) Voss) at each location, although this was not always possible. The criteria for choosing individual trees was that each be the best potential crop tree of the species (a subjective judgment), under 1½ inches in diameter at breast height, within a 7½ foot radius of the sampling point.

Seventy-three trees were used for the correlation analysis; this sample was later enlarged to 121 trees for additional data on age variation.

Total height and current leader growth were measured in the field, as was leader growth for the prior two growing seasons. Age was determined from ring counts of cross sections made just above the root collar.

Age Variation

The sample trees ranged from 3 to 42 years old, the oldest being a balsam fir. The mean age of the 73 seedlings in the original sample was 10.96 years, with a standard deviation of ± 5.96 and a coefficient of variation of 54 percent. A breakdown of these data by species was as follows:

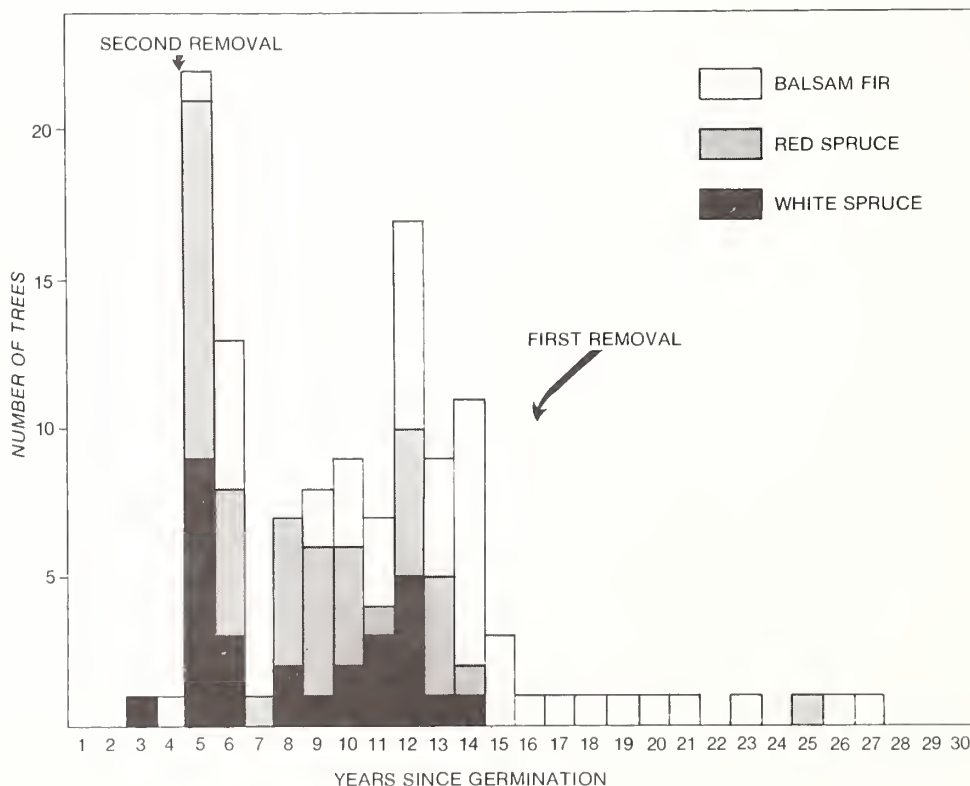
	Mean Age	S	CV
White spruce	8.00	± 3.34	42%
Balsam fir	14.03	± 7.08	50%
Red spruce	9.67	± 4.22	44%

These statistics can be misleading, however, as a plot of the data (expanded to a sample of 121 seedlings) shows a definite bimodal trend that appears to be related to the two overstory removals (Figure 1).

The first overstory removal, which began in the spring of 1957 and continued into the fall, apparently created conditions favorable to the establishment of new seedlings through succeeding growing seasons. Approximately one-third of the crop-tree-quality seedlings were between 12 and 15 years old in 1971. Thus they were established during the four growing seasons after the first harvest; the largest number were established during the fourth growing season.

The second overstory removal took place in the late summer and fall of 1967. Apparently this removal released one- and two-year-old seedlings (5 and 6 years old in 1971) that made up another third of the crop trees in our sample. Any regeneration after this removal

Figure 1.—Numbers of potential crop trees, by age class and species. One balsam fir 37 years old and one 42 years old are not shown.



was probably too small in 1971 to be included in our sample of potential crop trees.

There were slight variations in this trend by species. The 1965 growing season was extremely dry, which may account for the lack of potential crop trees established during that year. Also, the almost total lack of spruces among the potential crop trees that originated before the first overstory removal is interesting. In fact, the number of potential crop trees of all species that were established in the stand before the first removal is relatively low, considering the importance often placed on advance reproduction in the management of spruce-fir stands (fig. 1). This may indicate that seedlings established before cutting develop more slowly after release than newly established seedlings; it may also reflect a lack of adequate advance regeneration in the original stand, which was quite dense before harvest; or it may result from a combination of factors.

Growth Relationships

Correlations among total height, current leader growth, and age were evaluated.

Balsam fir, probably the most tolerant species of the three studied, had the lowest correlation among these factors, as illustrated by the following coefficients of determination (r^2):

	<i>Total ht.</i>	<i>Current growth</i>	<i>Age</i>
Total ht.	—	.282**	.334**
Current growth		—	.000 (NS)
Age			—

** Highly significant (.01 percent level).

NS—Non-significant.

Relationships for red spruce, probably less tolerant than balsam fir, were somewhat better.

	<i>Total ht.</i>	<i>Current growth</i>	<i>Age</i>
Total ht.	—	.674**	.661**
Current growth		—	.559**
Age			—

For white spruce, the least tolerant of the three species, coefficients of determination (r^2) were:

	<i>Total ht.</i>	<i>Current growth</i>	<i>Age</i>
Total ht.	—	.845**	.608**
Current growth		—	.364**
Age			—

Balsam fir, the species often considered the most tolerant among those studied, demonstrated the weakest relationships among total height, current growth, and age because it has the ability to survive for relatively long periods in a suppressed position. The two spruces, particularly white spruce, are lower on the tolerance scale and those trees that survive are usually in positions more favorable for growth.

It was possible to identify and measure internodal growth on the sample crop trees for several prior growing seasons. To determine whether there were strong relationships between the amounts of annual leader growth in successive years, correlation coefficients for growth between years were determined.

Annual Growth Correlations

	71-70	70-69	69-68
Fir	.658**	.814**	.668**
Red spruce	.630**	.591**	.249NS
White spruce	.873**	.856**	.600**

The relationships were not considered consistent enough to be of value in choosing crop trees that would grow faster. Generally these young trees are just emerging from a host of competitive influences that affect growth. This, along with the myriad other variables that may limit leader growth, restricts the validity of past growth as a predictor of future growth. Once the seedlings reach a more stable competitive environment, it is reasonable to expect a more consistent relationship between the amounts of growth in successive years.

Conclusion

The need for information about the development of individual spruce and fir seedlings will increase with the advent of intensive silvicultural practices. We need to take a hard look at advance regeneration, and more particularly "well established" regeneration that can be relied on to reproduce the next stand.

Although the information in this case history is by no means conclusive because of

sampling limitations, it does present some interesting conclusions and questions that warrant further investigation. For instance:

1. Most of the individual trees presently judged to be potential crop trees, particularly the spruces, were not present in the stand before it was first cut. It appears that seedlings established as a direct result of the two shelterwood removals, rather than advance reproduction present under the old stand, produced most of the potential crop trees on the area studied. This raises the question of whether adequate advanced regeneration, adequate in quantity or in quality, can be obtained in stands that have not been subjected to intermediate harvests or to modifi-

cation of the crown canopy from natural causes.

2. There was considerable variation in the ages of trees we considered potential crop trees, and regeneration appears to be a continuing process related loosely to the over-story removals.

3. Internodal growth was not a consistent indicator of future growth in height.

4. Total height and current growth were significantly related in the two spruces, as were age and total height. These relationships were considerably weaker in the more tolerant balsam fir.

—BARTON M. BLUM

Research Forester
Northeastern Forest Experiment Station
Orono, Maine

MANUSCRIPT RECEIVED FOR PUBLICATION 12 FEBRUARY 1973